Mathematics

Study plan for third-cycle subject

The subject plan was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.

Subject title

Mathematics (Matematik)

Subject description and programme outcomes

Scientific field

Mathematics studies spatial and numerical quantities and their relationship and applications. This study can be divided up in a large number fields. Many fields are represented on KTH, such as algebraic geometry, algebraic topology, differential geometry, dynamic systems, harmonic analysis, combinatorics, commutative algebra, complex analysis, mathematical physics and numerical analysis. Both theoretical and applied research is carried out.

The said fields reply be based together for a broad supply of courses and specialisations that reflect the research activities that are on KTH then the graduate program in mathematics. Other fields within the subject can also come in question, and the program are thought to dynamic be able to include new developments over the time.

The education intends to give basic knowledge within the different branches of the mathematics a good insight in research methodology, orientation in current problems and, on at least a field, knowledge and skills that are sufficient for and lead to an independent conducted research work at the enough high level. The education is completed with Degree of Doctor. It can be natural to take Degree of Licentiate first. Possibility is also only to take Degree of Licentiate. The education for third-cycle studies in mathematics is given by the section for mathematics on Department of mathematics at the school for technological sciences. The education will find a natural location within Stockholm's Mathematical Centres that KTH and SU have just formed.

Description of possible specialisation

The subject has no specialisations.

Specification of how the programme outcomes are to be achieved
The aim for the education is to make the student well prepared for independent research assignments within the mathematics or for other assignments where requirements are set on an in-depth understanding of mathematics and mathematical research methods.

This implies that the doctoral student after the education should be able to:

- describe and explain theories, design principles and empirical results in his area of specialization
- formulate concrete research issues within his area of specialization
- use established research methods and provide new knowledge
- analyse and evaluate own and others' research results critically
- present and discuss research results for colleagues public and in teaching
- analyse and take position in ethical aspects of research within the subject and act thereafter
- identify the need for new knowledge and have knowledge of how to initiate and lead research
- participate in interdisciplinary cooperations and show knowledge of different views on the research role in the social progress and analyse and evaluate connected issues critically.

All of the above listed skills should in a natural way be developed under the supervision process. Courses should contribute to develop the skills described in 1st, 3rd, 6th and the 8th point. To participate in seminars and to teach and participate in conferences contribute to develop the skills described in 2nd, 4th, 5th and the 7th point.

**Current research**

**Programme structure**

The education is carried out under the guidance of a principal supervisor together with an or several assistant supervisors. An individual study plan should be established in consultations between doctoral student and principal supervisors. The doctoral student and the principal supervisor should update the study plan at least once a year. The doctoral student's progress should be assessed at least once a year. It is natural that the assessment takes place in connection with up- the date of the study plan. It established or updated levels are established by the head of graduate studies at the school. About the doctoral student's progress is not near to what has been prescribed in the study plan can measures be taken in accordance with KTH's regulatory frameworks. The individual study plan should be adapted to the prior knowledge and to the specialisation of the thesis.

The education for third-cycle studies consists of a course module and an dissertation part with mutual point conditions according to the below.

**Compulsory and recommended courses**

The doctoral student should alone, in consultation with his supervisor (primarily the principal supervisor), take responsibility because the courses are chosen so that a sufficient specialisation within the chosen field and an appropriate broadening within the program and against possible relevant applied subjects is achieved.

All research teams at the section for mathematics (at the establishment of the graduate program, the groups are Algebra and Geometry, and Analysis and Combinatorics) gives a set of courses within his respective fields.
A selection of the courses is core courses: they are given regular (the aim is at least every second year), can be regarded as essential for a doctoral student within the specific field and is appropriate for all doctoral students in the program. These courses constitute a joint basis for the program and each doctoral student within the program read normally a substantial number of these courses.

Other subject courses that are stated are a selection of the courses that are given by the research teams. Additional courses can come in question.

The following selections give a good image:

Core courses:
Commutative algebra and algebraic geometry
Homological algebra and algebraic topology
subject course:
Applied topology
Topology
Prime number
Clifford algebras, geometric algebra and applications
Matrix groups
Toric geometry
Algebraic geometry: calculations and applications
Algebraic spaces
Elliptic bends
Computational number theory
Lie algebras
Vector bundles and characteristic classes
Commutative algebra
Scheme theory II.
Courses at SU:

Algebra IV

Galois theory

Representation theory

Number theory

Differential geometry for algebraists

Algebraic geometry (surfaces, $\acute{A}$tale cohomology)

Algebraic geometry (Hartshorne, parts of chapter. II, III)

Introduction to the theory of spectral sequences

Young tableaux.

Courses within Analysis

The following selections give a good image:

Core courses:

Functional Analysis

Integration theory

Chaotic dynamic systems

Topology

Elementary differential geometry

Fourier analysis

Differential geometry

Mathematical analysis for doctoral students.

subject course:

Mathematical theory of option pricing

Potential theory

Wavelets
Mathematical hydrodynamics
Random matrices
Partial Differential Equations
Methods in elliptic and parabolic PDE
Dynamics of strings and membranes
Obstacle problems in mathematical physics and industry
Inverse problems
Operator theory: a simple introduction
Spectral theory and usages
Semi-riemannian geometry 2
Non-linear wave equations
Homogenisation, oscillation and chance in PDE and FRP
Semi-riemannian geometry 1
Fractal geometry and measurement theory
Stochastic analysis
Fourier analysis
Viscosity solutions left fully non-linear PDE
Integrable systems
Several complex variables.
Courses at SU:
Topics in advanced analysis
Partial Differential Equations
Geometric multilinear analysis
Analytical functions 2.
Courses within Combinatorics
The following selections give a good image:

Core courses:

Applied combinatorics
Combinatorics
Graph theory

subject course:

Topology
Commutative algebra and algebraic geometry
Homological algebra and algebraic topology
Topological combinatorics
Coxeter groups
Algebraic combinatorics
Graph theory for doctoral students
The hyperplane arrangement
Polytope theory

Chosen subjects in combinatorics

Broadening courses

Certain relevant courses on advanced level and third cycle are appropriate broadening courses within the program. Examples of such courses:

Computational methods left micro and macro scales
Algebraic statistics
Projects within industrial and applied mathematics.

Other courses

In the coursework can also be included courses on teaching and learning in higher education. University pedagogical education is a requirement, if teaching should take place for first-cycle studies or second cycle under the education time.

Seminar activity
The student for third-cycle studies should under his education take part in and contribute to the scientific activity that is carried out within his field by often attending seminars and give a seminar a year about his work in the area normally.

Own seminar is evaluated to 1 credit (however in all no more than 5 credits). A regular participation in the general mathematical colloquium and relevant seminars and guest lectures outside the field be expected also. This also applies to seminars and guest lectures on the Department of Mathematics SU, Institutes Mittag-Leffler and NADA.

**Thesis**

The work with the thesis or the licentiate thesis should be started as soon as possible after the third cycle studies have been started. The subject for the thesis should be chosen in consultation with the principal supervisor and should connect to the research that is at the section for mathematics.

The thesis or the licentiate thesis is a compulsory part of the education for third-cycle studies. This part of the education aims at developing the student's ability to give independent contributions to research and cooperating to scientific studies within and outside his/her own subject. The thesis or the licentiate thesis should contain new research results that the student has developed alone or in collaboration with others. The scientific main results should satisfy the quality requirements for publication in internationally confessed magazines and proceedings with referee system. The student's contributions to in the thesis included texts that have several authors should be able to be stated.

The thesis or the licentiate thesis should normally be written in English. It can either be designed as a compilation of scientific articles or as a monograph thesis. In the previous the case should it be a particularly written summary.

Irrespective of if the thesis is intended become monograph or compilation thesis should international publication of achieved results be sought under the graduate student period.

**Entry requirements and selection**

**General and special admission requirements and prior knowledge**

General entry requirements are defined by general rules according to Higher Education Ordinance and KTHs internal regulations for education for third-cycle studies.

For specific entry requirements, it is required that the applicant's education has a specialisation in mathematics for second cycle studies or a close field strong related to mathematics. Furthermore, good knowledge in English is required, both in numbers and in writing.

**Selection rules and procedures**

The selection is made among the applicants who satisfy the entry requirements. At the selection, the grade of the applicant's maturity and ability to independent assessment and the important aspects of critical analysis constitute. Strong emphasis is placed at learning outcomes in courses of deeper character or in the form of degree projects as the degree project.
The programme’s degrees and examinations

Degree of Licentiate and Degree of Doctor (PhD)

Licentiate and Degree of Doctor been taken in accordance with KTHs general rules.

The programme’s examinations

No other compulsory tests are included in the education.